
सल्फ्यूरिक अम्ल — सुरक्षा सहिता

(द्वितीय पुनरीक्षण)

Sulphuric Acid — Code of Safety

(Second Revision)

ICS 13.300; 71.060.30

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भारतीय मानक ब्यूरो
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FOREWORD

‘This Indian Standard was adopted by the Bureau of Indian Standards on recommendation of the Chemical Hazards Sectional Committee and approval of the Chemical Division Council’.

Sulphuric acid is an important industrial chemical principally used in the manufacture of fertilizers, chemicals, explosives, textiles, rayon and petroleum refining. It is unfortunate that coupled with the important and large volume use of sulphuric acid, it is also one of the most corrosive and hazardous chemicals. Handling of sulphuric acid, therefore presents various hazards which can be better prevented than cured. Working according to a sound code of practice will reduce the frequency of hazards and also, in many cases the amount of damage caused by an accident. Sulphuric acid which has free sulphur trioxide dissolved in it is known as ‘oleum’ and ‘fuming sulphuric acid’ since it fumes copiously in contact with air.

The properties of sulphuric acid listed in Clause 4 have been taken from literature and have been included for information only. Moreover, these properties pertain to pure sulphuric acid. Bureau of Indian Standards has published a separate standard IS 266 : 1993 on the requirements and the methods of sampling and test for sulphuric acid intended for industrial purposes.

This standard was originally published in 1967 and revised in 2002. In this second revision general properties have been incorporated and modifications have been made to update toxicological data, health hazard, storage and preventive measures based on the currently available data and last two decades experience.

The various clauses of the standard have also been aligned with the format being applied for all Indian Standards on Code of safety of chemicals.

There is no ISO standard on this subject. In preparation of this code, assistance has been derived from the following publications:

- a) Encyclopedia of Chemical Technology — Ulman, 7th Edition.
- b) Sulphuric Acid, Online edition of Encyclopedia of Occupational Health and Safety, 2011. International Labour Office, Geneva.
- c) State Factories Rules for Corrosive Substances and Chemical Works, made under Section 87 of the *Indian Factories Act, 1948*.

The composition of the Committee responsible for the formulation of this standard is given at Annex A.

Indian Standard
Sulphuric Acid – Code of Safety
(Second Revision)

1 SCOPE

1.1 This standard prescribes a code of safety concerning hazards relating to sulphuric acid. It describes the properties and essential information for safe handling and use of sulphuric acid.

1.2 The standard does not, however, deal with any specification for the design of building, chemical engineering plant, and equipment for waste disposal. General precautionary measures in these respects should be taken.

2 REFERENCES

The Indian Standards listed below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	Title
1260 (Part 1) : 1973	Pictorial marking for handling and labelling of goods: Part 1 Dangerous goods (<i>first revision</i>)
4155 : 1966	Glossary of terms relating to chemical and radiation hazards and hazardous chemicals

3 TERMINOLOGY

For the purpose of this standard, definition of terms given in IS 4155 shall apply.

4 PROPERTIES

4.1 General Information

Sulphuric acid is one of the most corrosive and hazardous chemicals. Handling of sulphuric acid, therefore, presents various hazards which we better prevent than cured. Working according to a sound code of practice will reduce the frequency of hazards and also, in many cases, the amount of damage caused by an accident.

4.1.1 *Chemical Name — Sulphuric Acid.*

4.1.2 *Common name and Synonym — Oil of Vitriol, Battery Acid, Chamber Acid, Spent Sulphuric Acid.*

4.1.3 Uses

Sulphuric acid is an important industrial chemical principally used in the manufacture of fertilizers, chemicals, explosives, textiles, rayon and petroleum refining.

4.2 Identification

4.2.1 *Formula — H_2SO_4*

4.2.2 *CAS Number — 7 664-93-9*

4.2.3 *UN Number — 1 830*

4.2.4 *UN Class — 8, No Subsidiary Risk*

4.2.5 *Hazchem Code — 2 P*

4.3 Physical Properties

4.3.1 *General — Clear, Colourless Oily Liquid*

4.3.2 *Molecular Mass — 98.1*

4.3.3 *Physical State — Liquid*

4.3.4 *Colour — Colourless, Clear to Cloudy*

4.3.5 *Odour — None (Oleum has a Sharp Penetrating Odour)*

4.3.6 *Flammability — Non-Flammable*

4.3.7 *Hygroscopicity — Very Hygroscopic*

4.3.8 *Density (99 Percent Acid) — 1.834*

4.3.9 *Boiling Point (98 Percent Acid) — 279.6 °C*

4.3.10 *Freezing Point — 10.5 °C*

4.3.11 *Vapour Density (Air = 1) — 3.4*

4.3.12 *Specific Gravity (Water = 1) at 20 °C — 1.84*

4.3.13 *Viscosity at 30 °C — 20.10 cP*

4.3.14 *Vapour Pressure at 20 °C — Less Than 0.001 mm Hg*

4.3.15 *Solubility in Water — Completely Soluble with Generation of Heat*

4.3.16 *Solubility in Other Solvents — Soluble in Ethyl Alcohol in All Proportions*

4.3.17 *Polarity — Anhydrous H_2SO_4 is a Very Polar Liquid (Dielectric Constant ~ 100)*

4.4 Chemical Properties

4.4.1 Reactivity

The acid in concentrated form is a strong oxidizing and sulphonating agent. It destroys organic matter with evolution of heat and toxic sulphur dioxide and carbon monoxide; and attacks many metals with evolution of flammable hydrogen gas. Contact with such products as nitrates, carbides, chlorates fulminates, picrates, etc, may cause fire or explosion. Dilution with water evolves considerable heat. It also attacks some forms of plastics, rubber and coatings.

4.4.2 Corrosivity

Highly corrosive to most metals, particularly at concentrations below 93 percent, with evolution of hydrogen gas.

4.5 Fire and Explosion Hazard Properties

4.5.1 Ignition Temperature — Not Available.

4.5.2 Auto Ignition Temperature — Not Available.

4.5.3 Flash Point — Not available.

4.5.4 Upper Explosive Limit — Not available.

4.5.5 Lower Explosion Limit — Not available.

4.5.6 Fire Risk

The acid is non-flammable but in higher concentration may cause ignition by contact with organic or combustible materials and such products as nitrates, carbides, chlorates and metallic powders. There is likelihood of highly flammable hydrogen gas being generated inside a drum, tank car or a metal storage tank containing sulphuric acid. In as much as hydrogen gas will form explosive mixtures with air under certain conditions, smoking or open lights should not be permitted near the open drums or tank cars. The acid, in contact with metallic sulphides, may cause evolution of hydrogen sulphide which may form flammable and toxic mixture with air, (inhalation of hydrogen sulphide may lead to sudden death).

5 HEALTH HAZARD AND TOXICITY INFORMATION

5.1 General Information

Sulphuric acid is rapidly destructive to any tissue of the body with which it comes in contact, causing severe burns, due to its dehydrating actions which may be accompanied by shock and collapse. Sulphuric acid causes local effects on the skin and eyes and systemic effects. It can cause damage to eyes, respiratory tract, skin and mouth on exposure. Fatal exposure can occur through routes like ingestion. Appropriate precaution in handling is essential to prevent exposure.

5.2 Routes of Entry

5.2.1 Skin

Repeated contact with dilute solutions may cause dermatitis. The acid mist severely irritates the skin. Repeated exposure to sulphuric acid mist causes dermatitis.

5.2.2 Eyes

Contact with eyes very rapidly causes severe damage which may be followed by total loss of sight. The acid mist severely irritates the eyes. Repeated exposure to sulphuric acid mist causes chromic conjunctivitis.

5.2.3 Ingestion

Swallowing of the acid may cause severe injury or death. Repeated exposure to sulphuric acid mist causes stomatitis.

5.2.4 Inhalation

The acid mist severely irritates the respiratory tracts. Inhalation of concentrated vapour from hot acid or oleum may cause rapid loss of consciousness with serious damage to lung tissues. Individual sensitivity to such vapour is variable, 0.125 to 0.5 ppm may be mildly annoying, 1.5 ppm to 2.5 ppm definitely unpleasant and 10 ppm to 20 ppm are unbearable. Repeated exposure to sulphuric acid mist causes tracheobronchitis. Severe exposures may cause pneumonitis. Erosion of the teeth also occurs, particularly to those accustomed to mouth breathing.

5.2.5 Toxicity Information

a) Threshold Limit Value (TLV) – 1 mg/m³

b) Lethal concentration -50 (LC₅₀) with 1 mm particle size, 8 h exposure.

For adult guinea pigs – 50 mg/m³

For young animals – 18 mg/m³

5.3 Antidote

There is no antidote for sulfuric acid

6 PERSONAL PROTECTIVE EQUIPMENT

6.1 General

6.1.1 Personal protection scheme depends upon the effectiveness of employees education, training and supervision. Personal protective equipment and pre-placement physical examinations are precautionary measures to avoid accidents and not a substitute for safe working on the part of the personnel. Prior to assignment of processes involving the handling of sulphuric acid, all individuals should have a careful preplacement physical examination.

6.1.2 Employees handling sulphuric acid should be provided with the following equipment:

- a) Safety helmets, rubber gloves, rubber high top safety boots and rubber aprons. A rubber acid suit is recommended for tank wagon loading or unloading. The trouser should not be inserted into the high top safety boots (gum boots/knee boots). Instead, the openings in gum boots should be covered by spreading trousers round the gum boots;
- b) Suitable gas-tight chemical safety goggles; and
- c) Approved masks and breathing apparatus for respiratory protective as given in Table 1.

Table 1
Approved Masks and Breathing Apparatus for Respiratory Protection
(Clause 6.1.2)

S No.	Concentration mg/m ³	Minimum Protection
(1)	(2)	(3)
i)	1-50	Gas mask with full face-piece with acid gas canister and high efficiency particulate filter.
ii)	51-100	Air respirator with full face-piece operated in pressure demand or other positive pressure mode.
iii)	Above 100 or escape from unknown concentrated or fire fighting	Self-contained breathing apparatus with a full face-piece operated in pressure demand mode or other positive pressure mode.

6.2 Adequate personal protective equipment shall be available for emergency use throughout the plant or in an area where sulphuric acid is stored or used. Personnel should be trained to appreciate the process hazards, and the emergency and routine use of personal equipment. Personal protective equipment should be frequently examined and maintained in good condition. Eye fountains, emergency showers, and drench tubs covered with a thin sheet of polyethylene to keep the water clean, should be located in all areas where there is danger of acid splashing.

7 STORAGE, HANDLING, LABELLING AND TRANSPORT

7.1 Storage and Handling

7.1.1 Sulphuric acid is highly corrosive to most metals. For concentration from 93 percent to 99 percent, it may be stored satisfactorily in mild steel tanks, drums and glass carboys. For concentration below 93 percent, it shall be stored in glass carboys, earthenware jars or other suitable containers lined with acid-resistant materials. Storage should be located in the open or in well ventilated buildings or sheds. Natural ventilation is sufficient. Sulphuric acid stored in any type of metallic container would evolve hydrogen which is highly flammable and explosive. Pressure inside the container may build upon this account. Such pressure should be relieved

frequently by opening plugs of the metallic containers or alternatively such containers should be provided with safety vents.

7.1.2 Even small quantities of sulphuric acid should be stored away from other chemicals, especially organic materials, nitrates, cyanides and sulphides, chlorates, carbides, metal powders, oxidizing chemicals, peroxides and explosives.

7.1.3 Containers of sulphuric acid should be inspected regularly for leaks. Damaged containers should be handled with special care.

7.1.4 Electrical wiring should be made of acid-resistant insulation and encased in rigid metal or Poly Vinyl Chloride (PVC) conduits. Smoking shall be strictly prohibited where sulphuric acid is stored.

7.1.5 Each storage tank should be provided with a vent of sufficient size. The vent should be of a type which will maintain the tank at atmospheric pressure and which is capable of being cleaned easily. The vent should be fitted with a column made of acid resistant transparent material packed with granules of self-indicating silica-gel with adequate moisture holding capacity. The spent silica gel should be replaced by regenerated one as soon as colour change is noted. Alternatively, a device to scrub the entering air by concentrated sulphuric acid may be provided. For inspection, the top of the tank should

be accessible by an independent metallic ladder without the use of the top of the tank which is likely to be corroded due to action of acid mist.

7.1.6 All tanks should be placed squarely on good foundation and raised off the ground by at least two layers of acid-proof bricks. The tanks should be mounted with a slight slope towards the sludge hole or outlet valve. A plug operated from the top of the tank should be provided over the outlet valve. Gauge glasses in acid tanks should be avoided.

7.2 Labelling

7.2.1 The storage containers shall be labelled or marked to identify:

- (a) The contents of the container;
- (b) The name and address of the manufacturer or importer of the hazardous chemical; and
- (c) The physical, chemical and toxicological data as per the criteria given in the relevant Schedule of the Manufacture, Storage and Import of Hazardous Chemicals Rules 1989. While referring to the statutes, the stipulations given in the subsequent amendments of those statutes shall be taken into account.

7.2.2 Each container shall carry an identifying label or stencil depicting the symbol given in IS 1260 (Part 1) and containing the following information:

SULPHURIC ACID (OR OLEUM)

DANGER! CAUSES SEVERE BURNS

- › Avoid breathing vapour (Oleum).
- › Do not get in eyes, on skin, or clothing. In case of contact, flush affected part with water for at least 15 min.
- › Do not add water to contents. Do not store with oxidizing agents, organic materials, alkalis, explosives and metallic powders. Reacts with metal and gives off hydrogen which is flammable and explosive. Wash off any spillage of the acid with liberal quantities of water.

NOTE — For labelling and posting the tank cars carrying sulphuric acid, the provisions for transport of dangerous materials under Central Motor Vehicle Act and Rules, 1989. While referring to the statutes, the stipulations given in the subsequent amendments of those statutes shall be taken into account.

7.3 Transport

7.3.1 General

Loading, carrying at sea & discharging of Sulphuric acid involve high risk and require sophisticated handling for safety, health and loss prevention reasons. They need careful consideration prior loading, tank coating compatibility, cross compatibility with other cargoes carried, environmental controls if required.

7.3.1 Ensure that there is on board sufficient acid resistant hoses for the cargo transfer. Ensure that there is on board sufficient acid spray shields to cover flanges on manifold and hose connections.

NOTE — If transport of the hazardous chemical is involved it shall be carried out in accordance with the Central Motor Vehicles Rules, 1989. While referring to the statutes, the stipulations given in the subsequent amendments of those statutes shall be taken into account.

8 SPILLAGE, LEAKAGE AND WASTE DISPOSAL

8.1 Spillage and Leakage

Spilled acid should not be left unattended. Wash with water or cover with dry sand, ash or gravel, if the use of water is impossible. Remaining traces of acid should be neutralized with soda ash or lime. Do not mop up the acid with cloth or rags. The sand or ash absorbed with acid should be disposed off in secured sanitary land fill. Diluted acid may be neutralized before disposing off in sewerage or water.

8.2 Disposal of used Containers and Waste Material

8.2.1 Disposal of Empty Containers

8.2.1.1 Before returning, completely drain the contents and tightly close all openings.

8.2.1.2 Do not use sulphuric acid containers for any other liquid, especially in case of drums.

8.2.1.3 Drums should be emptied by gravity only with the use of a faucet or safety siphon fabricated from the material resistant to sulphuric acid.

Application of pressure to the drum for this purpose is extremely dangerous and should never be attempted.

8.2.2 Waste Disposal

Sulphuric acid waste should be diluted and neutralized before discharge into sewers. Limestone or soda ash may be used as neutralizing agents.

9 PROTECTION OF MAINTENANCE CREW

9.1 The hazardous nature of tank inspection, cleaning or repair requires that the maintenance crew be carefully trained for the purpose. All tank work should be done under the direct supervision of a foreman. The following precautions are recommended.

9.1.1 Pipelines in or out of the tank or other apparatus should be shut off or disconnected preferably by removing a complete small section and a blank flange should be installed on the open end to protect against human error and unsuspected leak.

9.1.2 Before entering a tank, it should be tested whether further washing is necessary, and that no harmful gas or vapour is present.

9.1.3 Proper personal protective equipment should be worn by any one entering a tank for inspection, cleaning or repairs.

9.1.4 The tools used for working inside plants should be of non-sparking type.

9.1.5 A safety belt and life line for a man entering the storage tank should be provided. A man on the outside of the tank should keep the men in the tank under constant observation and at least two other men should be available to help those in the tank in case of trouble. Entry into the tank and working on acid pipelines may be allowed only with permit to work system. If outside person has to enter the tank to rescue the affected person inside the tank, the self-contained breathing apparatus with full face piece and pressure demand or other positive pressure mode should be worn.

10 PREVENTIVE MEASURES AND FIRST AID

10.1 Preventive Measures

Handling of sulphuric acid presents various hazards, which may be avoided from time to time by observing the principal precautions set forth below:

- Avoid contact of sulphuric acid with eyes, skin and clothing.
- Wear rubber gloves, goggles, acid-proof aprons and boots while handling sulphuric acid or oleum.

- Never add water or caustic solution to sulphuric acid. While diluting always add acid to water with constant stirring.
- In the event of accidental contact, wash affected areas with plenty of water for at least 15 minutes. Irrespective of the degree of seriousness of an accident, first-aid or medical attention, or both, should be rendered at the earliest opportunity.
- In case of spillage of sulphuric acid, it should be first washed down with large quantities of water. Mild alkaline solution may be used afterwards to neutralize the last traces of the acid.
- The operations evolving sulphuric acid vapour/mist should be enclosed as far as possible and minimum required openings should be maintained with the adequate face velocities with the help of local exhaust arrangement.

10.2 First Aid

10.2.1 Speed in removing sulphuric acid is of primary importance. First-aid should be given in all cases of contact with sulphuric acid in any form, as delay in initiating treatment may result in serious injury.

10.2.2 General First-Aid

10.2.2.1 Apply copious quantity of running water. This is best provided for by situating readily accessible, well-marked, frequently-inspected, rapid-action safety showers. If the acid penetrates through the clothing, remove the clothing immediately and flush the skin with water.

10.2.2.2 Do not neutralize the acid with alkali. The heat of neutralization actually accentuates the burn.

10.2.2.3 In case of excessive burns, the patient may collapse or show shock symptoms, such as rapid pulse and sweating. Keep the patient in supine position (lying down on his back) and call the nearest physician.

10.2.2.4 No oil or ointment should be applied to affected areas without specific orders from the physician.

10.3 Contact with Eyes

The following precautions should be observed even if minute quantities of strong or dilute solutions of sulphuric acid enter the eyes:

- Immediately irrigate with copious quantity of running water for at least 15 minutes. A special eye-washing fountain, a ready source of running tap water or a hose with a soft gentle flow of drinking water should be available for eye irrigation.

- b) The eyelid should be held apart during the irrigation to ensure contact with eye tissues.
- c) A physician preferably an eye specialist should be called in without delay.
- d) If pain is still present, the eye irrigation should be continued for a second period of 15 min. After the first phase of eye washing, instil drops 2 or 3 drops of 0.5 percent solution of pontocaine or any equally effective aqueous topical anesthetic.
- e) No oil or oily ointment should be applied unless ordered by the physician.

10.4 Ingestion

Ingestion of even dilute solutions of the acid causes severe burn of the mucous membrane of the mouth, throat and stomach. Observe the following:

- a) Do not attempt to induce vomiting.
- b) Do not give anything oral to an unconscious patient.
- c) If the patient is conscious, encourage him to wash out his mouth with water and give him milk with white of eggs to drink.
- d) If these are not immediately available, give as much water as possible for drinking.
- e) Call a physician as soon as possible.

10.5 Inhalation

10.5.1 A worker exposed to sulphuric acid mist or oleum vapour should be at once removed to an uncontaminated area and a physician called at once. Oxygen may be administered but by an authorized person only.

10.5.2 If breathing has apparently ceased, artificial respiration should be started immediately.

11 DISPOSAL OF USED CONTAINERS AND WASTE MATERIAL

11.1 Disposal of Empty Containers

11.1.1 Before returning, completely drain the contents and tightly close all openings.

11.1.2 Do not use sulphuric acid containers for any other liquid, especially in case of drums.

11.1.3 Drums should be emptied by gravity only with the use of a faucet or safety siphon fabricated from the material resistant to sulphuric acid. Application of pressure to the drum for this purpose is extremely dangerous and should never be attempted.

11.2 Disposal of Waste

Sulphuric acid waste should be diluted and neutralized before discharge into sewers. Limestone or soda ash may be used as neutralizing agents.

ANNEX A
(Foreword)

COMMITTEE COMPOSITION
Chemical Hazards Sectional Committee, CHD 07

<i>Organization</i>	<i>Representative(s)</i>
In Personal Capacity	SHRI K. S. RAMPRASAD (<i>Chairperson</i>)
Alkali Manufacturers Association of India, Mumbai	SHRI K. SRINIVASAN SHRI H. S. DAS (<i>Alternate</i>)
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Central Leather Research Institute, Chennai	DR M. SURIYANARAYANAN
Centre for Fire, Explosives and Environmental Science, GoI, Min Of Def	SHRI S. P. DOBHAL DR AARTI BHATT (<i>Alternate</i>)
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Department of Chemicals and Petrochemicals, Ministry of Chemicals and Fertilizers, GoI	DR VISHAL CHOUDHARY
Department of Space (ISRO), Bengaluru	SHRI MURALEEKRISHNAN R. MISS LAKSHMI V. W. (<i>Alternate</i>)
Directorate General Factory Advice Service and Labour Institutes, Mumbai	SHRI H. M. BHANDARI SHRI P. G. SATPUTE (<i>Alternate</i>)
Gas Industries Association	SHRI SUNIL KHER SHRI ANOOP TANDON (<i>Alternate</i>)
Hindustan Unilever Limited, Mumbai	SHRI SANJAY HARLAKA SHRI RAKESH WADALKAR (<i>Alternate</i>)
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Indian Institute of Chemical Technology, Hyderabad	DR BANKUPALLI SATYAVATHI DR SRIPADI PRABHAKARC (<i>Alternate</i>)
Indian Institute of Petroleum, Dehradun	DR NEERAJ ATRAY DR PANKAJ KUMAR KANUJIA (<i>Alternate</i>)
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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website- www.bis.gov.in or www.standardsbis.

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